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46. Proposed by H. C. WHITAKER, A. M., Ph. D., Professor of Mathematics, Manual Training School, Philadelphia, Pennsylvania.

“There was an old woman tossed up in a basket  
Ninety times as high as the moon.”

*Mother Goose.*

Neglecting the resistance of the air, how long did it take the old lady to go up ?

I. Solution by E. L. SHERWOOD, A. M., Superintendent of City Schools, West Point, Mississippi.

The equation of motion is

$$1. \quad \frac{d^2 s}{dt^2} = -\frac{gr^2}{s^2}. \quad 2. \quad \left(\frac{ds}{dt}\right)^2 = \frac{2gr^2}{s} + c$$

where  $ds/dt$  or  $v=0$ , when  $S=90 \times 60.3R$  or  $5427R$ .

$$\text{Whence } C = -\frac{2gr^2}{5427R}.$$

$$3. \quad \left(\frac{ds}{dt}\right)^2 = \frac{2gr^2}{s} - \frac{2gr^2}{5427R} \text{ or } 2gr^2\left(\frac{1}{s} - \frac{1}{a}\right).$$

$$4. \quad dt = \sqrt{\frac{a}{2gr^2}} \cdot \frac{sds}{\sqrt{as-s^2}} \text{ solving } dt \text{ in (3).}$$

$$5. \quad t = \sqrt{\frac{a}{2gr^2}} \int_a^R \frac{sds}{\sqrt{as-s^2}} \text{ for } t=0 \text{ when } s=a.$$

$$6. \quad t = \sqrt{\frac{a}{2gr^2}} \left[ \left( \sqrt{as-s^2} - \frac{1}{2} a \operatorname{vers}^{-1} \frac{2s}{a} + C \right) \right]_a^R.$$

$$7. \quad t = \sqrt{\frac{a}{2gr^2}} \left( \sqrt{aR-R^2} - \frac{1}{2} a \operatorname{vers}^{-1} \frac{2R}{a} + \frac{\pi a}{2} \right) \text{ where } a=5427R.$$

$$8. \quad t=11.35 + \text{years, by substituting values and reducing.}$$

II. Solution by G. B. M. ZERR, A. M., Ph. D., Texarkana, Arkansas.

Let  $t$ =time,  $R=3963$  miles= $20924640$  feet=radius of the earth,  $g=32.2$  feet=gravity,  $a=90(60R)=5400R$ =distance the old woman was tossed.

$$\therefore t = \sqrt{\frac{a}{2gR^2}} \left( \sqrt{aR-R^2} - \frac{1}{2} a \operatorname{vers}^{-1} \frac{2R}{a} + \frac{\pi a}{2} \right).$$

$$t=30 \sqrt{\frac{3}{gR}} \{ R \sqrt{5399} - 2700R \operatorname{vers}^{-1} \frac{1}{5399} + 2700\pi R \}.$$

$t=355287708.316$  seconds= $11$  years,  $3$  months,  $7$  days,  $3$  hours,  $1$  minute,  $48.316$  seconds.

Also solved by *J. C. CORBIN*.

47. Proposed by *O. W. ANTHONY*, M. Sc., Professor of Mathematics in Columbian University, Washington, D. C.

What is the focus of the convex surface of a plano-convex lens, index  $\mu$ , which will converge parallel monochromatic rays to a given focus, the rays entering the lens on the plane side?

Solution by *G. B. M. ZERE*, A. M., Ph. D., Texarkana, Arkansas.

Let  $f$ =the given focal length.  $F$ =the focal length required,

$u$ =distance of origin of ray from lense,

$r, s$ , the radii of the first and second surfaces of the lense respectively,

$t$ =the thickness, and regard all distances as measured from the posterior surface.

Then we have for for a double convex lense,

$$\frac{1}{\frac{1}{f} + \frac{\mu-1}{s}} - \frac{1}{\frac{1}{u} - \frac{\mu-1}{r}} = \frac{t}{\mu}.$$

(See Parkinson's Optics, Art. 100, Cor. I, page 91).

Let  $u=r=\infty$ .

$$\therefore \frac{1}{\frac{1}{f} + \frac{\mu-1}{s}} = \frac{t}{\mu} \dots \dots \dots (1).$$

This is the plano-convex lense with light incident upon plane surface.

Write  $F$  for  $f$ , and let  $s=u=\infty$ .

$$\therefore \frac{1}{\frac{1}{F} + \frac{\mu-1}{r}} = \frac{t}{\mu} \dots \dots \dots (2).$$

This is the plano-convex lense with light incident upon the convex surface. Since we are using the same lense,  $r=s$ .

$$\therefore r=s=\frac{(\mu-1)ft}{\mu f-t}, \text{ from (1).}$$

$$\text{This value of } r \text{ in (2) gives, } F=\frac{t^2(\mu-1)}{(\mu f-t)^2}.$$

$\therefore F$  is found independent of the radius of convexity.